COMPACTION REPORT
KALAMA VALLEY SUBDIVISION, PHASE 1
LOTS 1-42, 53-75, 115-119, 156-178
AND 220-225
HAWAII KAI, OAHU, HAWAII

W.O. 423-10 APRIL 17, 1980

FOR

KALAMA ASSOCIATES

GEOLABS-HAWAII
1553 COLBURN STREET, SUITE 202
HONOLULU, HAWAII 96817

April 17, 1980

W.O. 423-10

Gray, Rhee & Associates, Inc.
116 S. King Street, Suite 508
Honolulu, Hawaii 96813

Attention: Mr. Dail Rhee

Subject: Compaction Report
Kalama Valley Subdivision, Phase 1
Lots 1-42, 53-75, 115-119, 156-178
and 220-225
Hawaii Kai, Oahu, Hawaii

Gentlemen:

This report summarizes our inspection, compaction and laboratory tests performed from April 3, 1979 to the present during the earthwork and grading operations at the above referenced Phase 1 portion of the project.

The major portion of the mass grading work was completed in September, 1979. Utility work and fine grading for the individual lots have been in progress to the present.

As of this date, the lots in Phase 1 have been mass graded to final grade and compacted adequately. The compaction test results for the in-place fill are presented in the attached compaction tests summary.

The general grading concept consisted of cutting the upper slope areas to remove the "adobe" soils and filling the lower central valley areas. The "adobe" soils thus removed would be used in the deeper fill areas, a minimum of 3 feet below the finish pad grade. The upper 3 feet of fill soils would consist of on-site non-"adobe" soils generated from the underlying cut material. The underlying soils below the surface adobe layer consisted mostly of boulder colluvium which was highly variable. The matrix material of the boulder colluvium consisted basically of silty clay to silty sand, however, "adobe" clay pockets were also encountered. Due to this variability of the available on-site capping material and some amount of "adobe" contamination from the grading operations, the soils utilized at the lot finished grade varied from low to highly expansive.

Some of the lots near the southern portion of the project had little or no grading. Since the mass grading operations did not remove or cap over the existing "adobe" clay soils here, "adobe" clay soils were encountered in some of these lots at finished grade.

Prior to fill placement, the existing vegetation was removed and the existing ground scarified and recompacted. The fill was then placed in horizontal lifts and compacted to a minimum of 85% ("adobe" clay) or 90% (Boulder Colluvium) of its maximum dry density.

During the fill placement operations, periodic field density tests were done in accordance with the American Society for Testing and Materials (ASTM) Test Designation D-1556 (Sand Cone Method).

During the grading period, various on-site soils were tested prior to being used in the field. The maximum dry densities and optimum moisture contents were established in our laboratory in accordance with ASTM Test Designation D-1557 (modified Proctor) and the test results are as follows:

Soil Type	Maximum Dry Density (p.c.f.)	Optimum Moisture Content (%)
"Adobe" Clay	99.0	24
Gray Silty Sand	99.4	23

Boulder Disposal

Due to the large amount of boulders on the site, boulder fill was utilized in the lower portions of the valley areas. The boulder fill was constructed by spreading a layer of boulders out, then filling the spaces between the boulders with layers of coral waste material jetted with water. A 2-foot layer of clay was then placed and compacted over the boulders and capped with a minimum of 3 feet of non-"adobe" on-site material. We recommended that the boulder fill be kept a minimum of 5 feet below the finished grade. Based on information from the project surveyors, the boulder fills are

located mainly below Lots 19, 35, 36, 118, 119, 156-159, 161, 166, 168, 169 and 171-176.

Lots 43 to 52

The mauka cut slope along the rear of these lots were designed at a very steep slope ratio of ¼:1 (H:V). This very steep slope ratio is only suitable for cuts in hard, unweathered basalt formation. During construction, the exposed soil materials on these cut slopes were substantially less competent than the anticipated rock formation.

The slope cut was initially made at ¼:1 to ½:1 (H:V) slope ratio. The cut slope was stopped after about 6 feet, when it was evident that the unweathered basalt rock formation would not be encountered close to the existing ground surface. The material exposed was a tuffaceous boulder material, moderately cemented. Therefore, a 5-foot bench was constructed and the remainder of the slope was cut at 1¼:1 slope ratio. Subsequent inspection of the slope face disclosed that drying of the exposed slope face had caused weakening of the soil and surface sloughing. It was also noted that the cementation of the deposit decreased substantially at the bottom portion of the cut.

Recommendations to reduce the sloughing and future instability of the slope were presented in our letters of June 11 and 15, 1979.

Subsequently, additional test pits excavated into the cut slope face encountered "adobe" clay layers with slickensided zones, which indicate the potential for substantial slope movement. A boulder buttress fill was then recommended to stabilize this loose, clay slope.

As of this date, our recommendations have not been implemented for the stabilization of the slope.

Therefore, these constructed lots are not presently recommended for development.

Boulder Protection

The upper hillside lots on both sides of the valley may be subject to boulders rolling down the hillside. This is an inherent risk for all hillside lots in any development.

The following recommendations have been presented previously to minimize the danger from boulders rolling down the hillsides.

1. Boulder sweeps along the upper boundaries of the site could be performed. However, the extent of the boulder sweep will be limited due to the steep terrain and difficult access into the areas beyond the project site.

2. The natural trees and vegetation along the upper portions of the site should be retained to act as a natural barrier against the boulders and to reduce erosion.

3. A boulder catchment area, about 10 to 15 feet wide, with a fence or wall could be utilized near the property boundary to catch rolling boulders. The concrete interceptor ditch along the upper boundaries of the site could be used in this capacity.

4. Where practicable, the houses should be set-back away from the toe of the hillside slope to create an additional boulder catchment area.

Due to the extensive hillside area beyond the project limits, the practicality of Item No. 1 was very limited and, therefore, not utilized for most of the project. Items 2, 3 and 4 were utilized instead.

Limited Boulder Sweep at Lots 10 thru 15

A limited boulder sweep utilizing laborers was conducted within the boundaries of Lots 10 through 15, since the concrete interceptor ditch was not originally planned behind these lots. Due to the very limited extent of the boulder sweep and the noted surface runoff from the hillside into the lots, it was decided to incorporate a drainage ditch and fence in the rear portion of these lots.

Limitations

It must be pointed out that an inherent risk of falling boulders could still exist for these hillside lots.

The state of the art of soil engineering practice has not advanced to a point that a solution is available for this area. It is our opinion that, no matter what one does, there is always the risk of boulders rolling down the hill, if not from areas near the house, it will come from areas high up on the slope. Whatever measure is chosen, it only reduces the risk. It should be pointed out that no guarantee against future falling boulders can be made due to changes in soil and rock conditions with time, weathering, erosion, earthquake and construction vibration; and improvements and construction activities at and around the site.

The owners of these hillside lots should be made aware of these limitations and cautioned against future improvements in the upper areas of the lots which may disturb the stability of the existing boulders.

Gunite Slope Lining Along Top of Concrete Channel

The fill slope behind the concrete channel walls, adjacent to Lots 23, 26, 27, 34, 167 and 168, have been constructed at relatively steep ratios of 1½:1 (H:V) instead of the recommended 2:1 (H:V). These slopes are about 5 to 6 feet high. This slope ratio was required in order to provide sufficient soil cover over sewer lines "C" and "E", located below this slope, which run parallel to the concrete channel. Due to the proximity of the underlying sewer pipe, normal 90 percent compaction of the upper fill material was difficult to achieve without damage to the pipes; therefore, these slopes are relatively loose.

In order to provide additional cover and protection, these slopes were covered with a wire mesh reinforced gunite lining. Due to the loose underlying fill, some future settlement of the fill and lining could be anticipated due to the weight of the soil and lining and possible water saturation of the existing fill.

Construction and maintenance of drainage swales to divert water away from these linings are essential to help reduce future cracking of the lining due to water saturation and erosion.

Deeper foundations have been recommended for the house footings near this slope to reduce the potential settlements due to settlement, and slope creep of this loose fill slope.

RECOMMENDATIONS

Foundations

Preliminary foundation design recommendations for the units were presented in our letters of May 30 and 31, 1979. These recommendations were based on a review of the project grading plans, preliminary plot plans and field observations during the initial stages of the grading operation. We recommended that these preliminary recommendations be reviewed after the actual subgrade soil conditions at finish grade were verified in the field.

It was assumed that sufficient non-expansive capping material would be generated during the cutting operations. However, due to the variability of the underlying tuffaceous boulder material encountered and some amount of surface "adobe" contamination, the soils available for use at finished grade varied from low to highly expansive.

As a result, some of the preliminary foundation recommendations were revised after field observation disclosed soil conditions different from those initially assumed.

Based on field observations of the subgrade soils encountered in the foundation excavations and laboratory soils tests, we have presented up-dated foundation recommendations for each lot as the subgrade soils were exposed.

Our foundation recommendations were made based on the assumptions that the foundations will be constructed properly and that proper drainage provided to shed water away from the foundations.

The foundation recommendations presented to-date will be summarized in a separate letter.

Lot Drainage

The finish lot grade outside the slabs, pavements and footings should be shaped and maintained to shed water away from the foundations and to avoid ponding condition. Also, the homeowners should be made aware that gutter water should be diverted far away from the perimeter footings and walkways. Excessive landscape and watering near the foundations and slab should be avoided.

These drainage requirements are essential for the proper performance of the above recommended foundations, since ponded water could cause excessive subsurface soil saturation and subsequent loss of strength or heaving.

Drainage swales must be provided and maintained to drain all surface run-off away from the slab and footing foundation.

Future Construction and Site Regrading

Due to the expansive nature of the on-site soils, future building additions, patio slabs and retaining walls should be designed by a soils engineer to minimize the shrink-swell effects of the underlying soils.

Swimming pools should be constructed with care as they may extend into the "adobe" material and be subjected to heaving and swelling movements and large forces generally associated with this type of soil.

Subsequent to completion of lot grading, utility trenches within the lot pad should be properly backfilled and compacted under the observation of a soils technician.

This office assumes no responsibility for any alterations made to slopes or pads on the subject lots subsequent to the issuance of this report without our knowledge and written approval.

We strongly suggest that all of the above referenced recommendations and restrictions be made available to all future lot and home purchasers of this subdivision, so that they be advised to include the consultation of a qualified professional in the planning, design and construction of any future improvements. Homeowners should also be advised not to block or alter surface drainage.

We trust this report is self-explanatory. Should you have any questions, please feel free to call this office.

Respectfully submitted,

C.W. ASSOCIATES, INC.
dba GEOLABS-HAWAII

By Bob Y.K. Wong
Bob Y.K. Wong, P.E.

Attachments: Summary of Density Tests (4)

XC: Kalama Associates

CSM:BYKW:cw

SUMMARY OF DENSITY TESTS CONTROL OF COMPACTED FILL				W.O. NO. 423-10 PAGE 1 OF 4		OWNER Kalama Associates JOB Kalama 6 Development			
TEST NO.	DATE	TEST LOCATION	ELEV. FT.	% COMP. REQ'D	MAX. DRY DENSITY P.C.F.	FILL MOISTURE %	TEST DRY DENSITY P.C.F.	% MAX. DRY DENSITY	REMARKS
1	5-17-79	N.W. corner Lot 67	F.G.	90	99.4	19.7	100.6	101.6	Pass
2	5-18-79	N.W. corner Lot 66	F.G.	90	99.4	11.2	96.6	97.6	Pass
3	6-9-79	Rd. "D" sta. 2 + 20	97	85	99.0	19.8	93.5	94.4	Pass
4	6-9-79	Middle of Lot 32	104	85	99.0	17.1	84.3	85.1	Fail
5	6-12-79	Middle Of Lot 28	98	90	99.4	22.3	69.3	69.7	Fail
6	6-12-79	Northern portion of Lot 27	97	90	99.4	28.3	75.5	76.0	Fail
7	6-12-79	Northern portion of Lot 32	105	90	99.4	26.4	93.7	94.2	Retest of Pass 4,5&6
8	6-14-79	Northern portion of east edge of Lot 28	101	90	99.4	20.5	96.0	96.6	Pass
9	6-14-79	Rd. "F" sta. 1 + 50	110	90	99.4	26.9	89.0	89.5	Pass
10	6-16-79	Rd. "G" sta. 1 + 10	126	90	99.4	11.8	122.4	123.0	Pass
11	6-16-79	South edge of Lot 176	131	90	99.4	28.5	113.9	114.6	Pass
12	6-16-79	Southern portion of west edge of Lot 177	132	90	99.4	32.8	83.7	84.2	Fail
13	6-16-79	Middle portion of Lot 176	132	90	99.4	25.9	86.3	86.8	Fail
14	6-18-79	Rd. "G" sta. 1 + 10	133	90	99.4	26.5	96.3	96.9	Retest of Pass 12&13
15	6-18-79	Rd. "G" sta. 1 + 80	132	90	99.4	29.8	80.7	81.1	Fail
16	6-18-79	Southern portion of Lot 177	132	90	99.4	23.4	106.9	107.5	Retest of 15 Pass
17	6-18-79	Southern portion of Lot 177	136	90	99.0	21.8	107.1	107.7	Pass
18	6-20-79	Western portion of Lot 1	109	85	99.0	28.5	88.7	89.6	Pass
19	6-20-79	East corner of Lot 7	119	85	99.0	28.1	109.3	110.4	Pass
20	6-20-79	East corner of Lot 7	125	85	99.0	34.0	90.4	91.3	Pass
21	6-22-79	Rd. "K" sta. 90+09	104	85	99.0	25.0	93.2	94.1	Pass
22	6-22-79	Rd. "K" sta. 90+69	107	85	99.0	27.9	84.3	85.1	Pass
23	6-29-79	Middle of Lot 162	122	85	99.0	34.7	77.1	77.8	Fail

SUMMARY OF DENSITY TESTS CONTROL OF COMPACTED FILL			W.O. NO. 423-10 PAGE 2 OF 4			OWNER Kalama Associates JOB Kalama 6 Development			
TEST NO.	DATE	TEST LOCATION	ELEV. FT.	% COMP. REQ'D	MAX. DRY DENSITY P.C.F.	FILL MOISTURE %	TEST DRY DENSITY P.C.F.	% MAX. DRY DENSITY	REMARKS
24	6-29-79	Middle of Lot 161	123	85	99.0	32.8	75.3	76.1	Fail
25	7-2-79	Middle of Lot 161	123	85	99.0	32.1	84.1	85.0	Retest of 23 Pass & 24
26	7-2-79	North corner of Lot 159	131	90	99.4	16.3	99.4	100.4	Pass
28	7-7-79	North corner of Lot 160	130	90	99.4	22.1	90.6	91.1	Pass
29	7-7-79	Rd. "C" sta. 2+42	132	90	99.4	23.6	70.5	70.9	Fail
30	7-7-79	Rd. "C" sta. 2+32	131	90	99.4	27.3	73.8	74.3	Fail
31	7-9-79	Middle Lot 118	136	90	99.4	26.6	88.2	88.8	Fail
32	7-9-79	Rd. "C" sta. 1+56	135	90	99.4	24.6	69.4	69.9	Fail
33	7-9-79	Middle Lot 118	136	90	99.4	25.9	88.8	89.4	Retest of 29 Pass to 32
34	7-11-79	Rd. "C" sta. 3+52	130	90	99.4	22.6	85.0	85.5	Fail
35	7-11-79	Rd. "C" sta. 3+42	130	90	99.4	20.9	94.7	95.3	Retest of 34 Pass
36	7-11-79	Conc. channel and sta. 4 + 83	112	90	99.4	21.5	91.0	91.5	Pass
37	7-11-79	S.E. corner of Lot 165	129	90	99.4	15.1	82.8	83.3	Fail
38	7-11-79	S.E. corner of Lot 165	129	90	99.4	22.4	94.9	95.4	Retest of 37 Pass
39	7-12-79	Middle Lot 158	125	90	99.4	17.7	121.4	122.1	Pass
40	7-13-79	Rd. "C" sta. 2+87	136	90	99.4	15.2	122.7	123.0	Pass
41	7-16-79	North end of Lot 118	141	90	99.4	24.4	77.0	77.5	Fail
42	7-17-79	East edge of Lot 115	148	90	99.4	24.1	77.0	77.5	Fail
43	7-19-79	Middle of Lot 119	142	90	99.4	18.9	87.9	88.4	Fail
44	7-19-79	North end of Lot 118	141	90	99.4	26.4	83.9	84.4	Fail
45	7-20-79	N.W. corner of Lot 157	143	90	99.4	32.1	92.5	93.1	Retest 41-44 Pass
46	7-23-79	Rd. "C" sta. 2+67	145	90	99.4	24.3	72.6	73.1	Fail

SUMMARY OF DENSITY TESTS CONTROL OF COMPACTED FILL				W.O. NO. 423-10		OWNER Kalama Associates			
				PAGE 3 OF 4		JOB Kalama 6 Development			
TEST NO.	DATE	TEST LOCATION	ELEV. FT.	% COMP. REQ'D	MAX. DRY DENSITY P.C.F.	FILL MOISTURE %	TEST DRY DENSITY P.C.F.	% MAX. DRY DENSITY	REMARKS
47	7-23-79	N.E. corner of Lot 118	141	90	99.4	30.3	78.7	79.1	Fail
48	7-26-79	N.W. corner of Lot 25	100	90	99.4	36.4	71.0	71.4	Fail
49	7-26-79	Middle of Lot 25	97	90	99.4	31.3	88.8	89.3	Retest of 48 Pass
50	7-26-79	North portion of Lot 26	96	90	99.4	28.2	81.2	81.7	Fail
51	7-25-79	Rd. "C' sta. 1 + 25	147	90	99.4	28.0	89.4	90.0	Retest of 46 Pass & 47
52	7-27-79	South end of Lot 23	102	90	99.4	31.8	77.0	77.5	Fail
53	7-28-79	South end of Lot 22	106	90	99.4	24.9	80.0	80.5	Fail
54	7-28-79	Middle of Lot 27	99	90	99.4	33.0	91.7	92.3	Pass
55	7-28-79	Middle of Lot 27	99	90	99.4	36.3	104.8	105.4	Pass
56	7-28-79	N.W. corner of Lot 64	94	90	99.4	17.3	91.4	91.9	Pass
57	7-28-79	Middle of Lot 65	94	90	99.4	25.6	90.7	91.2	Pass
58	8-1-79	North end of Lot 162	146	90	99.4	19.6	85.2	85.7	Fail
59	8-1-79	North end of Lot 160	144	90	99.4	29.8	83.7	84.2	Fail
60	8-1-79	Middle of Lot 162	140	90	99.4	24.3	90.7	91.2	Retest of 58 Pass & 59
61	8-2-79	N.W. corner of Lot 65	95.4	90	99.4	35.7	93.5	94.1	Pass
62	8-2-79	Middle of Lot 27	97.3	90	99.4	37.7	92.0	92.6	Pass
63	8-2-79	South end of Lot 25	97.8	90	99.4	28.4	83.5	84.0	Fail
64	8-2-79	Middle of Lot 25	98.4	90	99.4	25.4	109.4	110.0	Retest of 50 Pass 52,53,63
65	8-2-79	Middle of Lot 65	95.0	90	99.4	28.2	86.3	86.9	Fail
66	8-2-79	North edge of Lot 64	95.0	90	99.4	22.8	91.1	91.7	Retest of 65 Pass
67	8-3-79	S.E. end of Lot 27	97.0	90	99.4	31.8	99.1	99.7	Pass
68	8-3-79	Middle of Lot 65	95.8	90	99.4	25.4	91.5	92.0	Pass
69	8-3-79	North edge of Lot 157	141	90	99.4	28.5	91.1	91.7	Pass

SUMMARY OF DENSITY TESTS CONTROL OF COMPACTED FILL			W.O. NO. 423-10			OWNER Kalama Associates			
			PAGE 4 OF 4			JOB Kalama 6 Development			
TEST NO.	DATE	TEST LOCATION	ELEV. FT.	% COMP. REQ'D	MAX. DRY DENSITY P.C.F.	FILL MOISTURE %	TEST DRY DENSITY P.C.F.	% MAX. DRY DENSITY	REMARKS
70	8-3-79	S.E. corner Lot 66	94.8	90	99.4	22.0	101.9	102.5	Pass
71	9-10-79	Garage Area Lot 66	98.5	90	Select borrow 138.7	9.3	146.2	105	Pass
72	9-10-79	Garage Area Lot 67	97.0	90	138.7	10.1	144.7	104	Pass
73	9-10-79	Garage Area Lot 66	99.39	90	138.7	11.4	140.8	102	Pass
74	9-10-79	Garage Area Lot 66	99.89	90	138.7	11.8	137.2	99	Pass
75	9-10-79	Garage Area Lot 67	98.02	90	138.7	11.3	163.4	118	Pass
76	9-11-79	Garage Area Lot 67	97.99	90	138.7	11.3	144.6	104	Pass
77	9-11-79	Garage Area Lot 67	98.44	90	138.7	15.0	134.3	97	Pass
78	10-31-79	Lot 19	113.25	90	crusher waste 127.0	12.5	114.9	90.5	Pass
79	10-31-79	Lot 18	115.25	90	127.0	11.9	116.7	92.0	Pass
80	10-31-79	Lot 16	119.35	90	127.0	12.2	118.1	93.0	Pass
81	11-6-79	Lot 18	117.17	90	127.0	12.6	114.1	89.8	Pass *
82	11-6-79	Lot 19	115.20	90	127.0	12.3	115.8	91.2	Pass
83	11-8-79	Lot 16, Garage	121.0	90	127.0	13.2	118.1	93.0	Pass
84	11-9-79	Lot 17	121.33	90	127.0	13.6	114.5	90.2	Pass
85	11-15-79	Lot 1, Garage	103.5	90	127.0	12.6	114.4	90.1	Pass
86	11-15-79	Lot 2, Garage	105.5	90	127.0	12.3	118.7	93.4	Pass
87	11-15-79	Lot 3, Garage	111.2	90	127.0	10.6	115.5	91.0	Pass
88	2-29-80	Lot 39	137	90	93.0	28.8	86.1	92.6	Pass

* Passed with additional rolling.

GEOLABS-HAWAII